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Project Report

PA-229-9
(RSP)

Data Reduction Program Documentation
ALC10

(Effective: April 1971)

C. R. Berndtson
R. H. French
D. E. Nessman

17 May 1971

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Lincoln Laboratory
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

DATA REDUCTION PROGRAM DOCUMENTATION ALC10 (EFFECTIVE: APRIL 1971)

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FOREWORD

This is the ninth report in the Data Reduction Program Documentation series. It is dated according to the date of completion of the documentation. No implication is made that this program will not subsequently be modified, amended, or superseded; on the contrary, the history of radar data processing is one of continuous evolution of techniques, and it is unrealistic to assume that steady-state has been reached. The PA-229 series is being published for the convenience of interested parties, and Lincoln assumes no responsibility for the correctness of the information presented, nor for its currency.

The preparation of reports in this series is under the Editorship of Charles R. Berndtson of Lincoln, and of D. Nessman and R. French of Philco-Ford Corporation. Inquiries, suggestions, corrections, criticisms, and requests for additional copies should be directed to C. R. Berndtson.

The principal contributor to this report was G. L. Shapiro (Philco-Ford). Due to the intricate, evolutionary manner in which the programs came into being, the editors regret that it is in general impossible to give due credit to all -- mathematicians or radar analysts or programmers -- who contributed to the definition and writing of the programs.

Alan A. Grometstein

CONTENTS

COMMON SYMBOLS AND ABBREVIATIONS

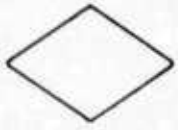
(The units given for certain quantities are the units commonly used for those quantities, unless otherwise noted.)

ADT	ALCOR Data Tape
ALCOR	ARPA-Lincoln C-band Observables Radar
ALTAIR	ARPA Long-Range Tracking and Instrumentation Radar
Alt	Altitude (km)
APS	Average Pulse Shape
ARS	ALTAIR Recording System
Avg	Average, Averaging
Az	Azimuth (deg)
c	Speed of Light
CADJ	Adjusted Calibration Constant (db)
C-band	ALCOR frequency, 5664 MHz (NB) and 5667 MHz (WB)
DBLT	Wide Band Pulse Doublet
El	Elevation (deg)
EOF	End of File
GMT	Greenwich Mean Time
h	Hours
Hz	Hertz
IF	Intermediate Frequency
in	Inches
LC	Left Circular Polarization
lsb	Least Significant Bit
min	Minutes
NB	Narrow Band
NRTPOD	Non-real Time Precision Orbit Determination Program
POD	Project PRESS Operation and Data Summary Report
Phase	Presented in deg
PRF	Pulse Repetition Frequency (pps)
PRI	Pulse Repetition Interval (s)
pps	Pulses per second
pts	Points

R	Range (km)
$\dot{R}$	Range Rate (km/s)
rad	Radians
RC	Right Circular Polarization
RCS	Radar Cross Section (dbsm)
RF	Radio Frequency
s	Seconds
SD_w	Standard Deviation of Wake Velocity
SDBLT	Wide Band Slaved Pulse Doublet
S/N	Signal-to-noise Ratio
T	Time
TAL	Time After Launch (s)
UHF	ALTAIR Frequency; 415 MHz
V	Velocity
V_d	Doppler Velocity
V_w	Mean Wake Velocity
VHF	ALTAIR Frequency; 155.5 MHz
WB	Wide Band
WBS	Wide Band Slaved
WTR	Western Test Range
θ	Total Off-axis Angle (deg)
λ	Wavelength
*	Denotes Multiplication

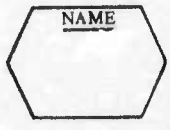
FLOW DIAGRAM SYMBOLS

PROCESS, ANNOTATION



DECISION

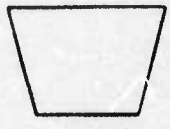
TERMINATOR



SUBROUTINE: where NAME is the entry call into the subroutine

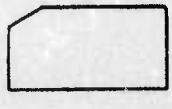
CONNECTOR: where P specifies a page in the flow diagram, and L designates a statement number in the program listing or a reference point in the flow diagram

CONNECTOR: where X implies a continuation of the diagram to the next page



INPUT/OUTPUT OPERATION

MAGNETIC TAPE



PUNCHED CARD

DISK

ALC10

I. PURPOSE and UTILIZATION

A. Source of Data

ALCOR[1]

B. Data Input

ALCOR Data Tape (ADT)

C. Description

ALC10 is designed to obtain ~~RCS~~ data on hard body targets ~~(NB and WB)~~ and on multiple radar scattering centers ~~(WB)~~. It produces plots vs ~~TAL~~ and ~~Alt~~ of the peak RCS from a set of gates or of the RCS in a selected gate.

D. Output

1. A listing of pertinent identification data.
2. Plots vs TAL and Alt of peak RCS or of RCS in a selected range gate.

II. DESCRIPTION

ALC10 computes average RCS as a function of range gate and time. The program averages in m^2 and then converts to dbsm for printouts and plots.

The averaging interval (AVINT) is input in seconds, and must be either 0.01, 0.02, 0.04, 0.05, 0.08, or 0.1. Based on AVINT and the primary pulse PRF, the number of pulses averaged is shown in Table I.

Only single pulse RCS data are computed if the range offset (XINOFF) is not zero.

RCS is computed as follows:

$$\text{LC RCS} = \text{XATBL(N)} + 40 \log R + \text{XPPAGC} + \text{CONLC} - \text{POWERT}$$

$$\text{RC RCS} = \text{XATBL(M)} + 40 \log R + \text{XOPAGC} + \text{CONRC} - \text{POWERT}$$

where

XATBL(N) is obtained by indexing the LC calibration table with the LC amplitude values obtained in the ADT data record.[1]

XATBL(M) is obtained by indexing the RC calibration table with the RC amplitude values obtained in the ADT data record.[1]

XPPAGC is total LC attenuation (db)[2]

XOPAGC is total RC attenuation (db)[2]

CONLC and CONRC are calibration constants (db) obtained from Calibration Record Words 624 (NB LC), 625 (NB RC), 627 (WB LC), and 628 (WB RC)

POWERT (peak transmit power in dbw) for NB
= PWRCN + PWRSN log XPKPWR

POWERT for WB
= PWRSN + PWRSW log XPKPWR

where

PWRCN is Calibration Record Word 620

PWRSN is Calibration Record Word 621

PWRCW is Calibration Record Word 622

TABLE I

AVERAGING PARAMETERS FOR ALC10

PRF (pps)	Pulse Spacing (s/pulse)	No. of Pulses Averaged					
		0.01[#]	0.02[#]	0.04[#]	0.05[#]	0.08[#]	0.1[#]
200	0.01[##]	1	2	4	5	8	10
160	0.0125[##]	(1)[†]	(1)	(1)	4	(1)	8
100	0.01	1	2	4	5	8	10
80	0.0125	(1)	(1)	(1)	4	(1)	8
50	0.02	(1)	1	2	2-3[††]	4	5
40	0.025	(1)	(1)	(1)	2	(1)	4
25	0.04	(1)	(1)	1	(1)	2	2-3[††]
20	0.05	(1)	(1)	(1)	1	(1)	2

[#] Averaging interval(s) (AVINT).

[##] When ALCOR transmits either 200 or 160 pps, the ADT tape (prior to April 71) has always contained every other pulse for a recorded PRF of 100 or 80 pps.

[†] If AVINT is not obtainable at the PRF without using fractional pulses, only one pulse is averaged (AVINT = 1/PRF).

[††] For this AVINT and PRF, 2 pulses and 3 pulses are averaged alternately.

PWRSW is Calibration Record Word 623

XPKPWR is ADT Record Byte 344

R, Az, and El are corrected as follows:

$$R = IRANGE + TRBIAS + TTCOR + RRCOR - RCORF$$

$$Az = IAZ + AZBIAS$$

$$El = IEL + ELBIAS - ECORF$$

where

IRANGE is uncorrected R

TRBIAS is range bias

TTCOR (transit time correction) = $R\dot{R}/c$

RRCOR is range doppler coupling correction

RCORF is tropospheric refraction correction

IAZ is Az encoder angle

AZBIAS is Az bias (Calibration Record Word 602)

IEL is El encoder angle

ELBIAS is El bias (Calibration Record Word 603)

ECORF is tropospheric refraction correction

Alt is computed as follows:

$$Alt = (R^2 + R_e^2 + 2 R R_e \sin El)^{\frac{1}{2}} - R_e$$

where

R_e = radius of earth (6378.145 km)

Before processing, the main program checks that ITBAND (tape) = IBAND (input). This determines that if WB data is requested, WB data exists on the tape requested.

III. OPERATION

A. Input

Number of cases

Launch time (total GMT ms)

Range offset (m)

Waveform and polarization

Averaging interval (s)

Start and stop range gates for peak RCS search

First and last pulse nos. of processing intervals and initial PRF

No. of processing intervals

A sample input is shown in Appendix A.

CARD 1 (I2)

(Col.)		
1-2	ICASEN	No. of cases

CARD 2 (I10, F10.1, 5I5, F5.2, 1X, A4)

1-10	ILNCH	Launch time in total GMT ms
11-20	XINOFF[#]	Range offset (m) (0)
21-25	NCELL1[#]	Initial gate for peak RCS plot (50)
26-30	NCELL2[#]	Final gate for peak RCS plot (54)
31-35	NBAND	0 = NB; 1 = WB
36-40	IPOLAR	0 = LC; 1 = RC
41-45	NVALS	No. of processing intervals
46-50	AVINT[#]	Averaging interval (s) (0.05)
52-55	TITL	Title for listing and plots

(U)[#] If left blank, program sets to indicated value.

CARD 3 (6I10)

(Col.)		
1-10	NSTART	First pulse no. of initial processing interval
11-20	NSTOP	Last pulse no. of initial processing interval
21-30	INPRF	PRF at first pulse of initial processing interval
31-40	NSTART	First pulse no. of second processing interval
41-50	NSTOP	Last pulse no. of second processing interval
51-60	INPRF	PRF at first pulse of second processing interval

Repeat Card 3 as necessary.

Repeat Cards 2 and 3 for each case.

B. Output

LISTING

Selected input parameters

No. of points to be plotted

Processing interval (TAL)

PLOTS

RCS vs TAL and Alt

Sample outputs are given in Appendix B.

IV. PROGRAM LIMITATIONS

NVALS	≤ 50 processing intervals
XIVALS	Either 0.01, 0.02, 0.04, 0.05, 0.08, or 0.1 s
IPRS	either 200, 160, 100, 80, 50, 40, 25, or 20 pps (any other PRF will give single pulse averaging)
XINOFF	Must be on tape
No. of averaging intervals	≤ 6000

V. PROGRAMMING

A. L10ALC (see Appendices C and D.)

L10ALC is the control section of ALC10. L10ALC reads the input cards, calls READGS and UNPACK, and averages the data returned. L10ALC also calls the subroutines that plot and print the data.

B. HEDADT (see Appendix E.)

Subroutine HEDADT unpacks the ADT header record which contains bandwidth, reel no., WTR no., date of mission, and mission designator. The call statement is HEDADT [ISIG[#], INBUF(1), IEQM(1)] .

INPUT

INBUF(1)	First word in the ADT header record[##]

OUTPUT

IEQM(1)	IZBAND	(bandwidth: 1 = WB, 0 = NB)
IEQM(2)	ITREEL	(reel no.)
IEQM(3)	ITWTR	(WTR no.)
IEQM(4)	IMTH	
IEQM(5)	IDAY	(Date of test)
IEQM(6)	IYR	
IEQM(7-9)	ITDESG	(mission designator)

C. READGS[†] (see Appendix F.)

The first call to subroutine READGS opens the file and reads the ADT header record. The second call to READGS reads the ADT calibration record and stores the values in a buffer area. L10ALC extracts the individual calibration values it requires. Each subsequent call to READGS reads an ADT data record consisting of eight ALCOR pulses.

[#] Not used.

[##] INBUF (2) to INBUF (1803) contain the remaining words in the record.

[†] Same as READJS[2] except rewind procedure is included.

D. UNPACK[2]

Subroutine UNPACK unpacks the raw data from the ADT, and translates it into a format usable by the IBM 360/67 computer.

E. REFC (see Appendix G.)

The tropospheric refraction correction subroutine, REFC, is based on tropospheric refraction tables in PPP-36[3]. A modified version of this subroutine is now in use.

The call statement is REFC (E, R, DEE, DRR)

E	Uncorrected El (must be between 0° and 90°
R	Uncorrected R (ft)
DEE	El tropospheric correction
ERR	R tropospheric correction (ft)

The corrected values to be computed after exiting from the REFC routine are:

El	= E - DEE
R (ft)	= R - DRR

F. CELPLT

Subroutine CELPLT plots the RCS vs TAL plots.

G. Plotting System Subroutines

They are REREAD, STOIDV, and PLTND.

REFERENCES

1. "ALCOR Data Users Manual", LM-86, Lincoln Laboratory, M.I.T. (17 June 1970), UNCLASSIFIED.

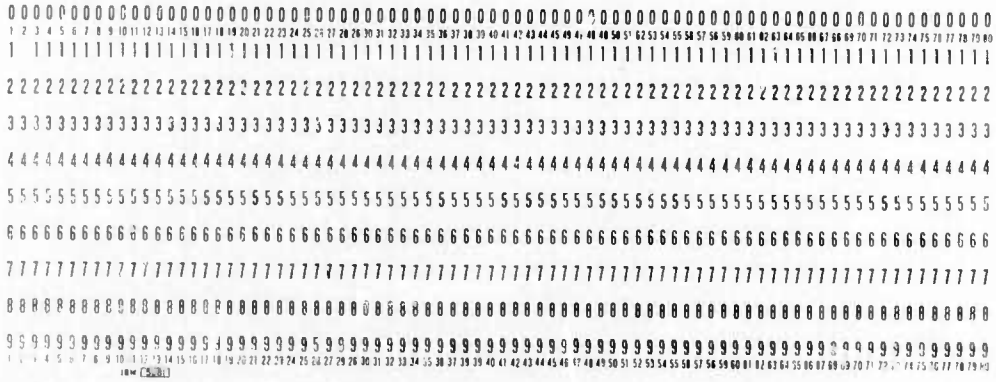
2. "Data Reduction Program Documentation, ALCOR Tape Read Package, (Effective: April 1971)", PA-229-7, Lincoln Laboratory, M.I.T. (26 April 1971), UNCLASSIFIED.

3. J.P. Penhune, "Refraction Corrections for the TRADEX Radar", PPP-36 Lincoln Laboratory, M.I.T. (21 April 1965), UNCLASSIFIED.

APPENDIX A
ALC10 INPUT

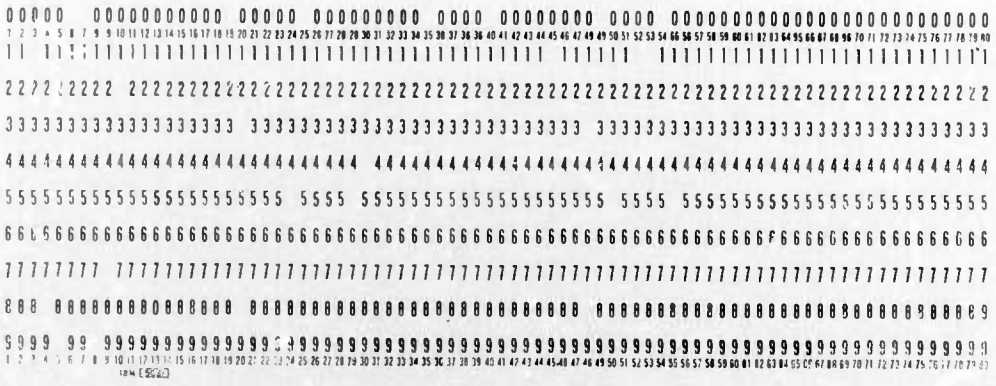
1

CARD 1



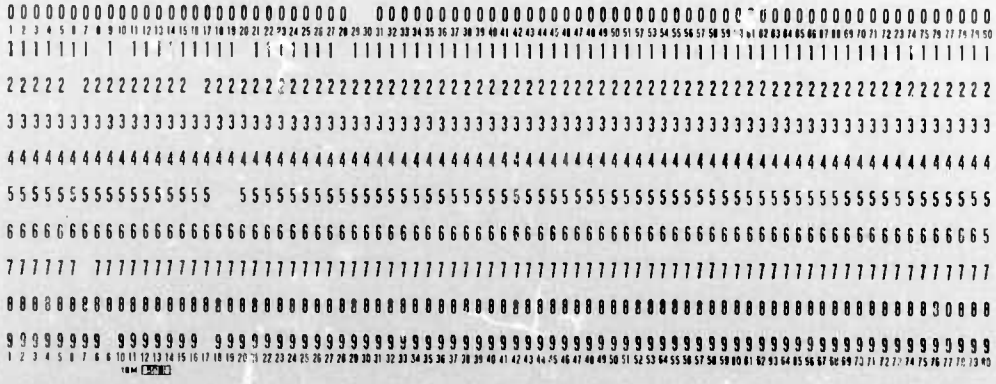
18900972 0. 50 54 0 0 1 .05 1J05

CARD 2



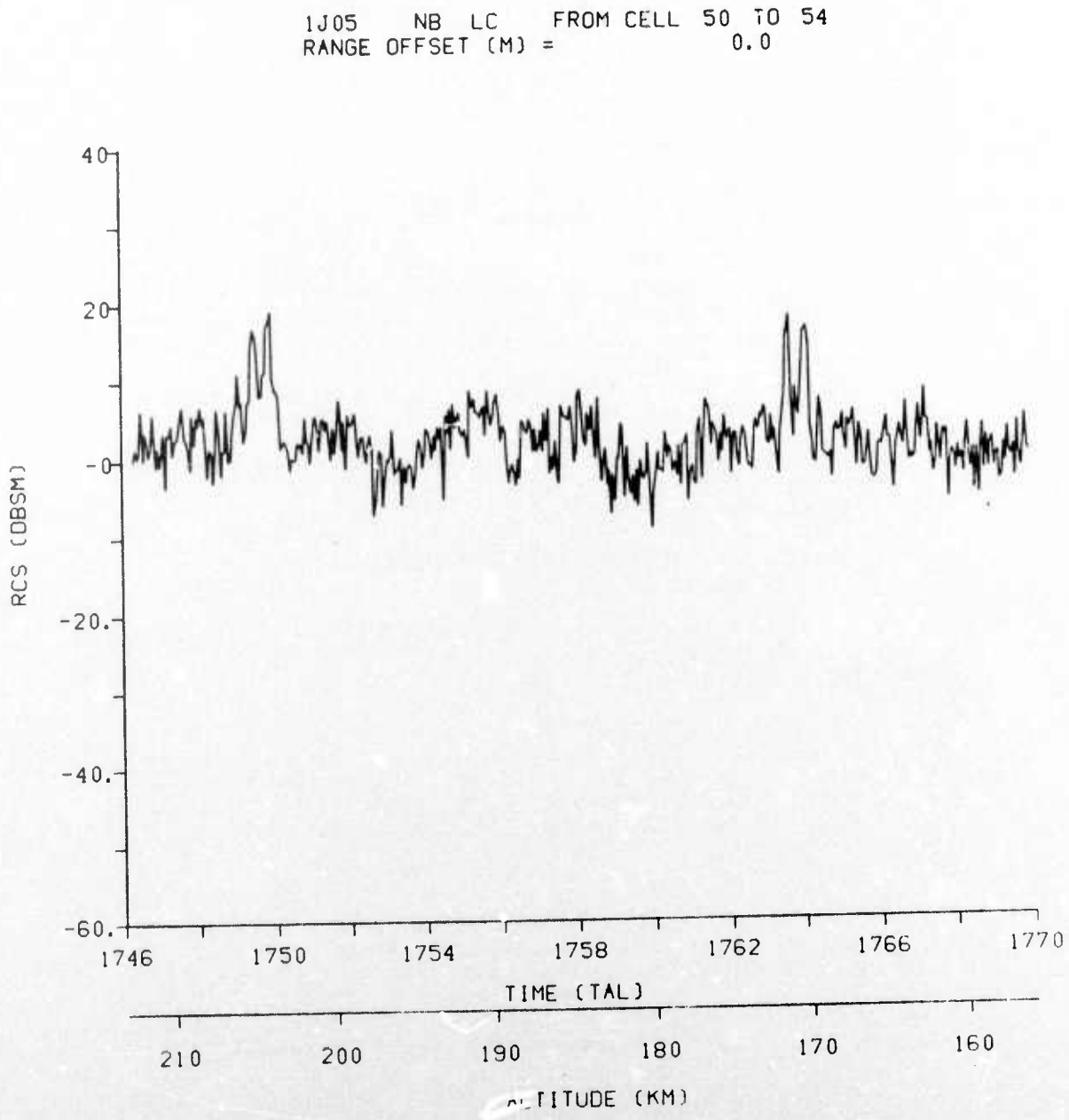
27191 29551 100

CARD 3



APPENDIX B
ALC10 OUTPUTS

```
L60-ALCOR   POLAR = LC    BAND = NB    REEL NO. =    2   TITLE = 1J05   DATE =  3/ 3/71

CELL BEGIN(SEARCH)=  50     KRCS(LC) =    -88.100  IBAND = 0

CELL END(SEARCH)) =  54     KRCS(RC) =    -88.900  IPOLAR= 0     NVALS =  1

 START   STOP  PRF          START   STOP  PRF          START   STOP  PRF          START   STOP  PRF
 27191  29551  100

     LIFT OFF TIME =  18900.972     AVERAGING INTERVAL (SECS) =     0.05    INPUT RANGE OFFSET (M) =        0.0

PLOT  473 POINTS FROM        1746.340 TO        1769.939          CASE NO    1   FROM CELL   50   TO CELL   54
```


1J05 NB LC FROM CELL 50 TO 54
RANGE OFFSET (M) = 0.0
40
20
-0
-20.
-40.
-60.
RCS (DBSM)
1746
1750
1754
1758
1762
1766
1770
TIME (TAL)
210
200
190
180
170
160
ALTITUDE (KM)

APPENDIX C
L10ALC PROGRAM LISTING

```
      DOUBLE PRECISION XLNCH,D1000
C
      DIMENSION NSTART(50),NSTOP(50)
      DIMENSION XLCSUM(170),XRCSUM(170),INPRF(50),
     1 XATBL(128),XLCDB(170),XRCDB(170),ILCAMP(170),IRCAMP(170)
     2,ILCPHA(170) ,IRCPHA(170)
      DIMENSION IPRS(8),I01(8,2),I02(8,2),I04(8,2),I05(8,2),I08(8,2),
     1 I10(8,2),IUSE(8,2),XIVALS(6)
      DIMENSION XNBUF(1803),PIFA(16),OIFA(16),          XKRCS(5)
      DIMENSION IEQM(9),ITDESG(3)
      DOUBLE PRECISION TCOM
C
      COMMON/ICOM/INBUF(1803),IAZ,IEL,INDEX,IPPRCS,IORS,IRANGE,IPKPWR,IR
     1DOT,IALT,INDAZ,JNDAZ,INDEL,IRB54,IRB85,IOPRCS,I240B1,I240B2,I240B3
     1,I241B1,I241B2,I241B3,XPPAGC,IBETA,NEWA,IBAND,NSW,RBIAS(8),ISVPRI,
     1IHRS,IMIN,ISEC,IMSEC,ISTAT(21),TRBIAS,ISTAT1,ISTAT2,ISTAT3,ISTAT4,
     1IALSW,ISTSW,NBWB,ISIGNO,I27812,JCON,NBEG,NEND,ITST,NUMPRI,XOPAGC,
     1ITBAND,ITAPNO,IPRF,IPOLAR,ISSERR,PIFA,CIFA,PFSA,OFSA,PSSA,CSSA,
     1PSSL,OSSL,ICODE,I27385,I27386,I27387,I27388,IMOVP,IMCVC,IOFFST,
     1IDAT(682)
      COMMON/PLOW/ALSAV(100),DBT  ,DBB  ,IRUN,KOUNT,NALT,NEWREQ,PLOTID(8
     1),CSRV(6000),TCOM(6000),TPINCH,TSAV(100),DPINCH,ICASE
C
      EQUIVALENCE (ILCAMP(1),IDAT(1)),(ILCPHA(1),IDAT(171)),(IRCAMP(1),
     1IDAT(341)),(IRCPHA(1),IDAT(511))
      EQUIVALENCE(XNBUF(1),INBUF(1))
      EQUIVALENCE (IEQM(1),IZBAND),(IEQM(2),ITREEL),(IEQM(3),ITWTR),
     2(IEQM(4) ,IMTH  ),(IEQM(5),IDAY ),(IEQM(6),IYR),
     3(IEQM(7),ITDESG(1))
C
      DATA ZLC/'LC  '/,ZRC/'RC  '/,ZWB/'WB  '/,ZNB/'NB  '/,BLANK/'    '/
      DATA IPRS/200,160,100,80,50,40,25,20/
      DATA XIVALS/.01,.02,.04,.05,.08,.10/
      DATA I01/ 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1/
      DATA I02/ 2, 1, 2, 1, 1, 1, 1, 1, 2, 1, 2, 1, 1, 1, 1, 1/
      DATA I04/ 4, 1, 4, 1, 2, 1, 1, 1, 4, 1, 4, 1, 2, 1, 1, 1/
      DATA I05/ 5, 4, 5, 4, 2, 2, 1, 1, 5, 4, 5, 4, 3, 2, 1, 1/
      DATA I08/ 8, 1, 8, 1, 4, 1, 2, 1, 8, 1, 8, 1, 4, 1, 2, 1/
      DATA I10/10, 8,10, 8, 5, 4, 2, 2,10, 8,10, 8, 5, 4, 3, 2/
      DATA ER /6378.145/
      DATA D1000/1000. D0/
C
C        IPOLAR = 0 LEFT CIRCULAR DATA REQUESTED
C        IPOLAR = 1 RIGHT CIRCULAR DATA REQUESTED
C        NBAND = 0  NARROW BAND DATA REQUESTED
C        NBAND = 1  WIDE BAND DATA REQUESTED
C        NEWA = 0   MISSION FLOWN BEFORE 15 OCT 70 (OLD ATTN.)
C        NEWA = 1   MISSION FLOWN AFTER  15 OCT 70 (NEW ATTN.)
C
```

```
      CALL STOIDV('ALC1060',6,0)
      CALL REREAD (99,530)
      KOUNT=0
      ICASE=0
      READ(5,13)ICASEN
   13 FORMAT(I2)
      IF(ICASEN.LE.0)ICASEN=1
    5 CONTINUE
      IFRST1=0
      IFRST2=0
      IFRST3=0
      IFRST4=0
      IAV=0
      JJ=0
      ICASE=ICASE+1
      IF(ICASE.GT.ICASEN)GO TO 127
       READ(5,1)ILNCH,XINOFF,NCELL1,NCELL2,NBAND,IPOLAR,NVALS,AVINT,
     1TITL,(NSTART(I),NSTOP(I),INPRF(I),I=1,NVALS)
    1 FORMAT(I10,F10.1,5I5,F5.2,1X,A4/(6I10))
C
      IF(AVINT.LE.0.)AVINT=.05
      IEOF=0
      IERR=0
      CALL READGS(INBUF,IEOF,IERR)
      IF(ICASE.GT.1)GO TO 14
      ISIG=1
      CALL HEDADT (ISIG,INBUF(1),IECM(1))
      ITBAND=IZBAND
      NEWA=0
      IF(IYR.GT.70)GO TO 282
      IF(IYR.LT.70)GO TO 283
      IF(IMTH.GT.10)GO TO 282
      IF(IMTH.LT.10)GO TO 283
      IF(IDAY.LT.15)GO TO 283
  282 NEWA=1
  283 CONTINUE
   14 IERR=0
      CALL READGS(INBUF,IEOF,IERR)
      IF(ICASE.GT.1)GO TO 12
C
C        STORE THE DESIRED CALIBRATION VALUES
C
      N=0
      DO 20 K=256,383
      N=N+1
   20 XATBL(N)=XNBUF(K)
C
      N=0
      DO 22 K=512,527
      N=N+1
   22 PIFA(N)=XNBUF(K)
      N=0
      DO 53 K=528,543
      N=N+1
   53 QIFA(N)=XNBUF(K)
C
      PFSA=XNBUF(592)
```

```
      PSSA=XNBUF(593)
      OFSA=XNBUF(594)
      OSSA=XNBUF(595)
C
      ABIAS=XNBUF(602)
      EBIAS=XNBUF(603)
      DEGCON=(180.*.0479369)/3141.59
      AZBIAS=DEGCON*ABIAS
      ELBIAS=DEGCON*EBIAS
C
      N=0
      DO 55 K=604,611
      N=N+1
   55 RBIAS(N)=XNBUF(K)
C
      PWRCN=XNBUF(620)
      PWRSN=XNBUF(621)
      PWRCW=XNBUF(622)
      PWRSW=XNBUF(623)
C
      N=0
      DO 57 K=624,628
      N=N+1
   57 XKRCS(N)=XNBUF(K)
C
      PSSL=XNBUF(629)
      OSSL=XNBUF(630)
C
   12 LGO=0
      DO 8 K=1,6
      IF((XIVALS(K)-AVINT).LE..005)LGO=K
    8 CONTINUE
      IF(LGO.NE.0)GO TO 9
      WRITE(6,793)AVINT
  793 FORMAT('0ILLEGAL AVERAGING INTERVAL',F12.3)
      GO TO 127
C
    9 GO TO (21,23,25,27,29,51),LGO
C
   21 DO 31 N=1,2
      DO 31 M=1,8
   31 IUSE(M,N)=IO1(M,N)
      GO TO 42
C
   23 DO 33 N=1,2
      DO 33 M=1,8
   33 IUSE(M,N)=IO2(M,N)
      GO TO 42
C
   25 DO 35 N=1,2
      DO 35 M=1,8
   35 IUSE(M,N)=IO4(M,N)
      GO TO 42
C
   27 DO 37 N=1,2
      DO 37 M=1,8
   37 IUSE(M,N)=IO5(M,N)
```

```
      GO TO 42
C
   29 DO 39 N=1,2
      DO 39 M=1,8
   39 IUSE(M,N)=I08(M,N)
      GO TO 42
C
   51 DO 41 N=1,2
      DO 41 M=1,8
   41 IUSE(M,N)=I10(M,N)
      GO TO 42
C
   42 CONTINUE
C
      JCON=-1
      INDEX=0
      ITST=1
      IPULS=0
C
      DO 120 IJ=1,NVALS
      NBEG=NSTART(IJ)
C
      DO 7 K=1,170
      XLCSUM(K)=0.
    7 XRCSUM(K)=0.
      IPRF=INPRF(IJ)
      INTAV=1
      IF( ABS(XINOFF).GT.1)GO TO 81
      DO 85 N=1,8
      IF(IPRS(N).NE.IPRF)GO TO 85
      INTAV=IUSE(N,1)
   85 CONTINUE
   81 JX=1
      GO TO 3
    2 CONTINUE
      JX=JX+1
      INTAV=1
      IF( ABS(XINOFF).GT.1)GO TO 3
      DO 83 N=1,8
      IF(IPRS(N).NE.IPRF)GO TO 83
      INTAV=IUSE(N,JX)
      IF(JX.EQ.2)JX=0
   83 CONTINUE
C
    3 JCON=JCON+1
      IF(JCON.EQ.9.OR.JCON.EQ.0)GO TO 97
      INDEX=(JCON-1)*900
      GO TO 99
   97 JCON=1
      INDEX=0
   98 IEOF=0
      IERR=0
      CALL READQS(INBUF,IEOF,IERR)
      IF(IEOF.NE.0)GO TO 127
      IF(IERR.EQ.1)GO TO 103
   99 CALL UNPACK
      XOFFST=(FLOAT(IOFFST)/2048.)*14.969625
```

```
      JOFFST=XOFFST
      IF(ICODE.EQ.5)XOPAGC=XPPAGC
      IF(ICODE.EQ.7)XOPAGC=XPPAGC
  101 IF(IFRST2.EQ.1)GO TO 92
      ZBAN=ZNB
      IF(ITBAND.EQ.1)ZBAN=ZWB
      ZPOL=ZLC
      IF(IPOLAR.EQ.1)ZPOL=ZRC
      IF(NCELL1.LE.0)NCELL1=50
      IF(NCELL2.LE.0)NCELL2=54
C
      PWRUS1=PWRCN
      IF(NBAND.EQ.1)PWRUS1=PWRCW
      PWRUS2=PWRSN
      IF(NBAND.EQ.1)PWRUS2=PWRSW
      CONLC=XKRCS(1)
      CONRC=XKRCS(2)
      IF(NBAND.NE.1)GO TO 17
      CONLC=XKRCS(4)
      CONRC=XKRCS(5)
   17 CONTINUE
      IF(ICODE.EQ.5)CONRC=CONLC
      IF(ICODE.EQ.7)CONRC=CONLC
      WRITE(6,200)ZPOL,ZBAN,ITREEL,TITL,(IEQM(I),I=4,6)
  200 FORMAT('1L60-ALCOR    POLAR = ',A2,4X,'BAND = ',A2,4X,'REEL NO. = '
     1,I5,'    TITLE = ',A4,'    DATE = ',I2,'/',I2,'/',I2)
      IF(ICASE.GT.1)GO TO 207
  207 WRITE(6,208)NCELL1,CONLC,NBAND
  208 FORMAT('OCELL BEGIN(SEARCH)= ',I3,5X
     1'KRCS(LC) = ',F10.3,2X,'IBAND = ',I1,5X)
      WRITE(6,210) NCELL2,CONRC,          IPOLAR,NVALS
  210 FORMAT('OCELL END(SEARCH)) = ',I3,5X
     1'KRCS(RC) = ',F10.3,2X,'IPOLAR= ',I1,5X,'NVALS = ',I2)
      WRITE(6,212)(NSTART(I),NSTOP(I),INPRF(I),I=1, NVALS)
  212 FORMAT('0 START    STOP  PRF',12X,'START    STOP  PRF',12X,'START
     1STOP  PRF',12X,'START    STOP  PRF' /(4(2X,I5,2X,I5,2X,I3,10X)))
      XLNCH=DFLOAT(ILNCH)/D1000
      WRITE(6,214)XLNCH,AVINT,XINOFF
  214 FORMAT('0      LIFT OFF TIME = ',F10.3,'      AVERAGING INTERVAL (SE
     1CS) = ',F8.2,'     INPUT RANGE OFFSET (M) = ',F10.1)
C
      RRUSE=-.00943
      IF(ITBAND.EQ.1)RRUSE=-.000115
      IF(NBAND.NE.ITBAND)GO TO 695
      IFRST2=1
   92 CONTINUE
C
  620 IF(NUMPRI.LT.NSTART(IJ))GO TO 3
      IF( ABS(XINOFF-XOFFST).GT.1.)GO TO 117
      ITST=1
  627 IPULS=IPULS+1
      IF(IPULS.LT.INTAV)GO TO 10
      IPULS=0
      ITST=2
C
   10 CONTINUE
      IF(IFRST4.EQ.1)GO TO 610
```

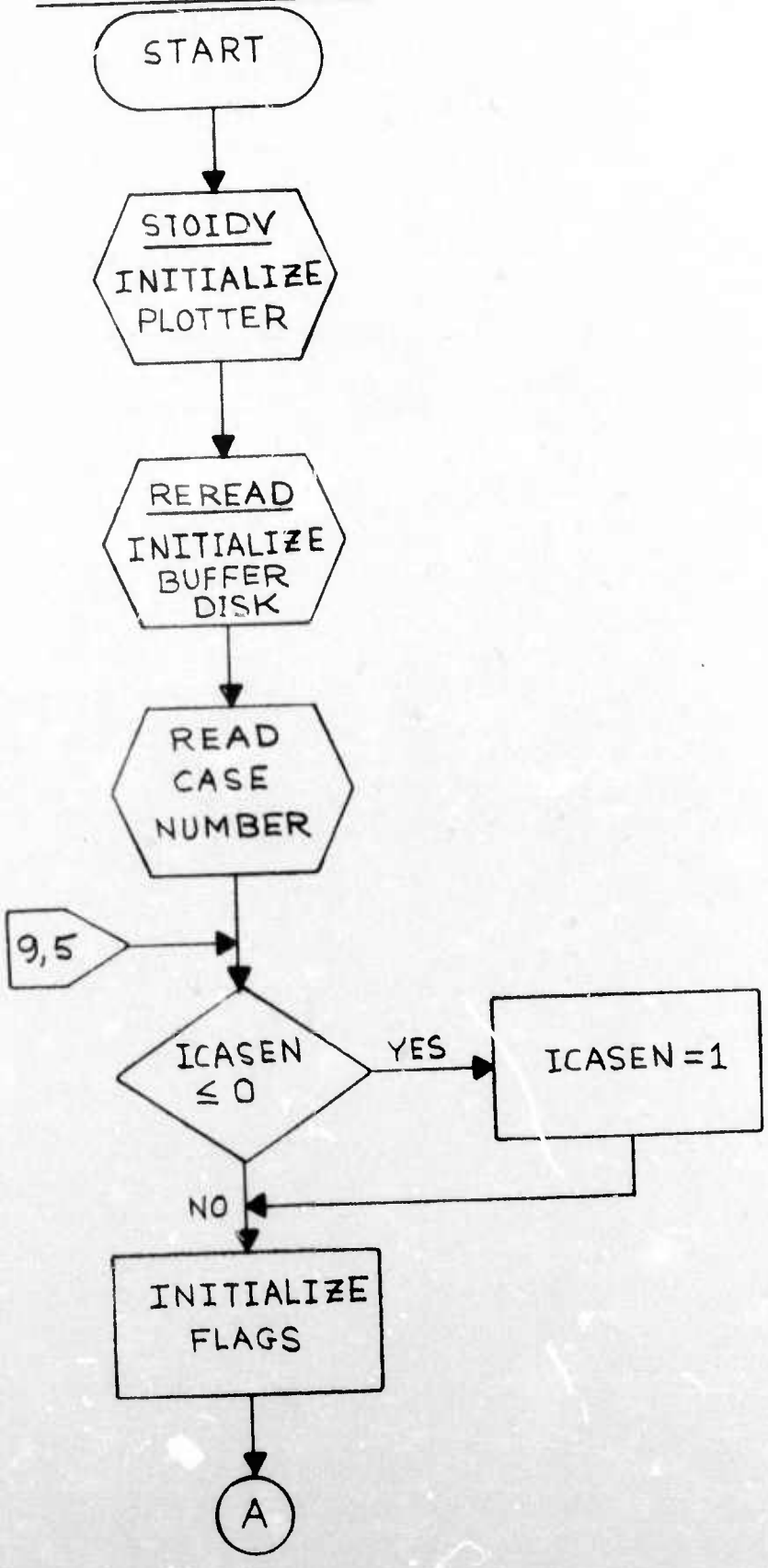
```
      IPRCLD=IPRF
      IFRST4=1
      GO TO 611
  610 IF(IPRF.EQ.IPROLD)GO TO 611
      WRITE(6,624)NUMPRI,IPROLD,IPRF
  624 FORMAT(/25X'CURRENT PRI = ',I8 ,'  OLD PRF = ',I5,'  CURRENT PRF =
     1 ',I5/)
  611 CONTINUE
      IF(ISSERR.NE.1)GO TO 617
      WRITE(6,612)ISVPRI
  612 FORMAT(' SLOW SWITCH BITS ARE BOTH = 0',5X,'  CURRENT PRI = ',I10)
  617 CONTINUE
      ITOT=(3600*IHRS+60*IMIN+ISEC)*1000+IMSEC
      ITAL=ITOT-ILNCH
      TAL=DFLOAT(ITAL)/D1000
      TOTL=DFLOAT(ITOT)/D1000
      RDOT=(IRDOT/(8192.0))*14.989625
      RANGE=(FLOAT(IRANGE)/2048000.)*14.989625+TRBIAS*.14989625
      TTCOR=    (RANGE/299776.)*(RDOT/1000.)
      RANGE=RANGE+TTCOR
      RRCOR=RRUSE*RDOT
      RANGE=RANGE+RRCOR/1000.
      EL=(IEL*2*3141.59266)/(2.0**17)
      XEL=EL*.0572958
      XEL=XEL+ELBIAS
      CALL REFC(XEL,RANGE,ECORF,RCORF)
      RNGE=RANGE-RCORF
      ELVE=XEL-ECORF
      RADEL=ELVE*.017453
       ALT=SQRT(RNGE**2+ER*ER+2.*RNGE*ER*SIN(RADEL))-ER
      RANGE=RNGE
      XTRR=40.*ALOG10(RANGE)
      XPKPWR=IPKPWR
      POWERT=PWRUS1+PWRUS2*ALOG10(XPKPWR)
C
      IF(IFRST1.EQ.1)GO TO 11
      TALBEG=TAL
      NPRBEG=NUMPRI
      ALTBEG= ALT
      IFRST1=1
   11 CONTINUE
C
      IAV=IAV+1
      IF(IPOLAR.EQ.1)GO TO 73
      DO 79 K=NCELL1,NCELL2
      N=ILCAMP(K)+1
      XLCDB(K)=XATBL(N)+XTRR+XPPAGC+CONLC-POWERT
      XLCSUM(K)=XLCSUM(K)+10.**(XLCDB(K)/10.)
   79 CONTINUE
      GO TO 74
   73 DO 76 K=NCELL1,NCELL2
      M=IRCAMP(K)+1
      XRCDB(K)=XATBL(M)+XTRR+XCPAGC+CONRC-POWERT
      XRCSUM(K)=XRCSUM(K)+10.**(XRCDB(K)/10.)
   76 CONTINUE
C
   74 GO TO (199,19),ITST
```

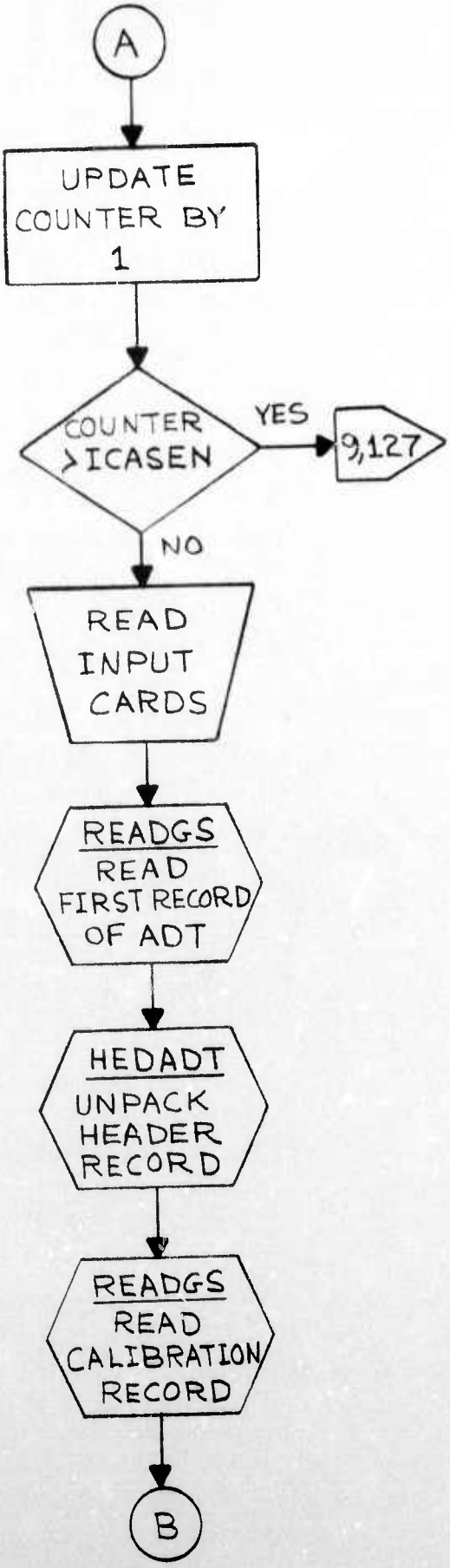
```
  199 IF(NUMPRI.NE.NSTOP(IJ))GO TO 117
C
   19 CONTINUE
      XDBPK=-1000.
      IF(IPOLAR.EQ.1)GO TO 77
      DO 72 K=NCELL1,NCELL2
      XLCDB(K)=10.*ALOG10(XLCSUM(K) /FLOAT(IAV ))
      IF(XLCDB(K).LT.XDBPK)GO TO 72
      XDBPK=XLCDB(K)
      IRGPK=K
   72 CONTINUE
      GO TO 93
   77 DO 78 K=NCELL1,NCELL2
      XRCDB(K)=10.*ALOG10(XRCSUM(K) /FLOAT(IAV ))
      IF(XRCDB(K).LT.XDBPK)GO TO 78
      XDBPK=XRCDB(K)
      IRGPK=K
   78 CONTINUE
   93 JJ=JJ+1
      IRUN=JJ
  255 IF(IRUN.GT.1)GO TO 260
      NALT=1
      TSAV(NALT)=TAL
      ALSAV(NALT)=ALT
      GO TO 360
  260 IALT1=IFIX(ALPREV/10.)
      IALT2=IFIX(ALT/10.)
      IF(IALT1.EQ.IALT2)GO TO 360
      IF(ALT.GT.ALPREV)GO TO 280
      ALTEST=IALT1*10
      GO TO 300
  280 ALTEST=IALT2*10
  300 NALT=NALT+1
      ALSAV(NALT)=ALTEST
      FAC=(ALTEST-ALPREV)/(ALT-ALPREV)
      TSAV(NALT)=TPREV+FAC*(TAL-TPREV)
  360 ALPREV=ALT
      TPREV=TAL
      TCOM(JJ)=TALBEG
      CSRV(JJ)=XDBPK
   71 DO 82 K=1,170
      XLCSUM(K)=0.
   82 XRCSUM(K)=0.
C
      IAV=0
      IFRST4=0
      IFRST1=0
      IF(JJ.GE.6000)GO TO 121
  118 IF(NUMPRI.LT.NSTOP(IJ))GO TO 2
  117 IF(NUMPRI.LT.NSTOP(IJ))GO TO 3
  119 IFRST3=0
      IPULS=0
      IAV=0
      IFRST4=0
      IFRST1=0
  120 CONTINUE
  121 CONTINUE
```

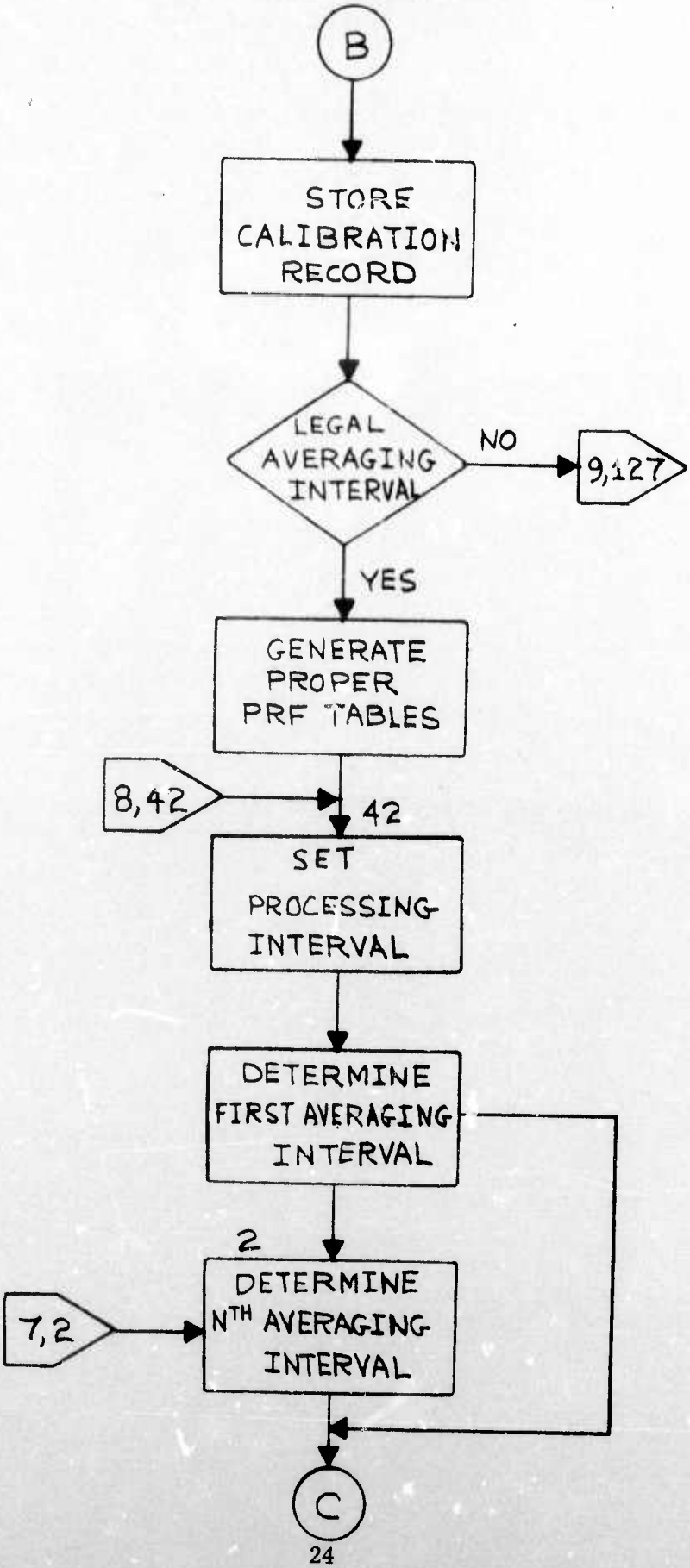
```
      NALT=NALT+1
      TSAV(NALT)=TAL
      ALSAV(NALT)=ALT
      NEWREQ=0
C
      GO TO 125
  103 WRITE(6,107)NUMPRI
  107 FORMAT('0PARITY ERROR ON READ AFTER PRI = ',I10)
      GO TO 99
  680 WRITE(6,109)NUMPRI
  109 FORMAT(' END OF FILE REACHED LAST NUMPRI VALUE = ',I10)
      GO TO 125
  695 WRITE(6,114)IBAND,ITBAND
  114 FORMAT(' INPUT BAND= 'I10,'   BAND ON TAPE = 'I10)
      GO TO 127
  125 PLOTID(1)=TITL
      PLOTID(2)=BLANK
      PLOTID(3)=ZBAN
      PLOTID(4)=ZPOL
      DO 126 K=5,8
  126 PLOTID(K)=BLANK
C
      TMIN=TCOM(1)
      TMAX=TCOM(JJ)
      WRITE(6,66)IRUN,TMIN,TMAX,ICASE,NCELL1,NCELL2
   66 FORMAT(         'OPLOT',I5,' POINTS FROM ',F15.3,' TO ',F15.3,
     110X,'CASE NO',I5,'   FROM CELL',I5,'   TO CELL',I5)
  640 CALL CELPLT TCOM,CSRV,JJ,PLOTID,NCELL1,NCELL2,ALSAV,NALT,TSAV,
     1XINOFF)
      IEOF=2
      CALL READGS(INBUF,IEOF,IERR)
      GO TO 5
  127 CALL PLTND
      RETURN
      END
```

APPENDIX D

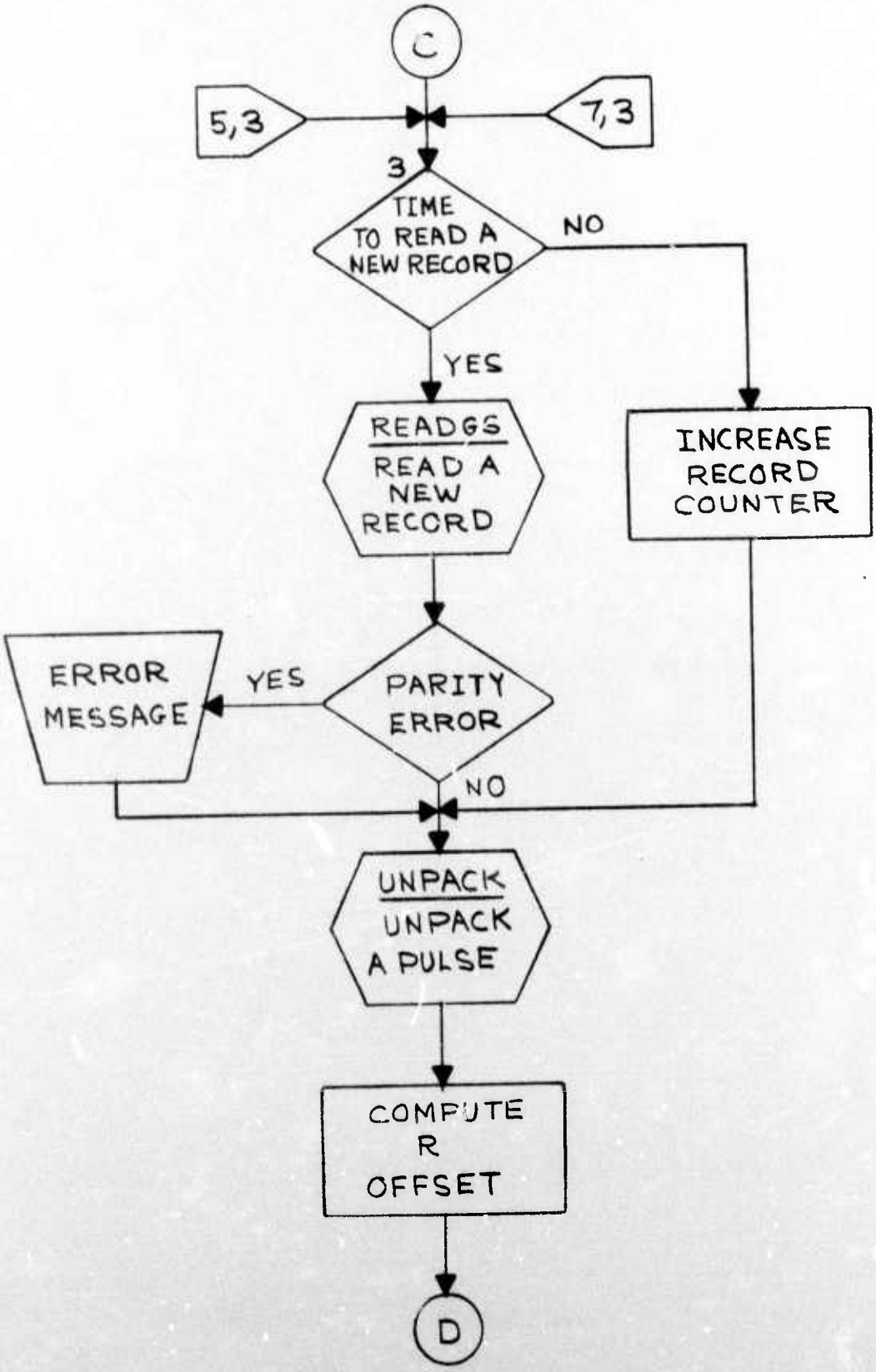
L10ALC FLOW DIAGRAM



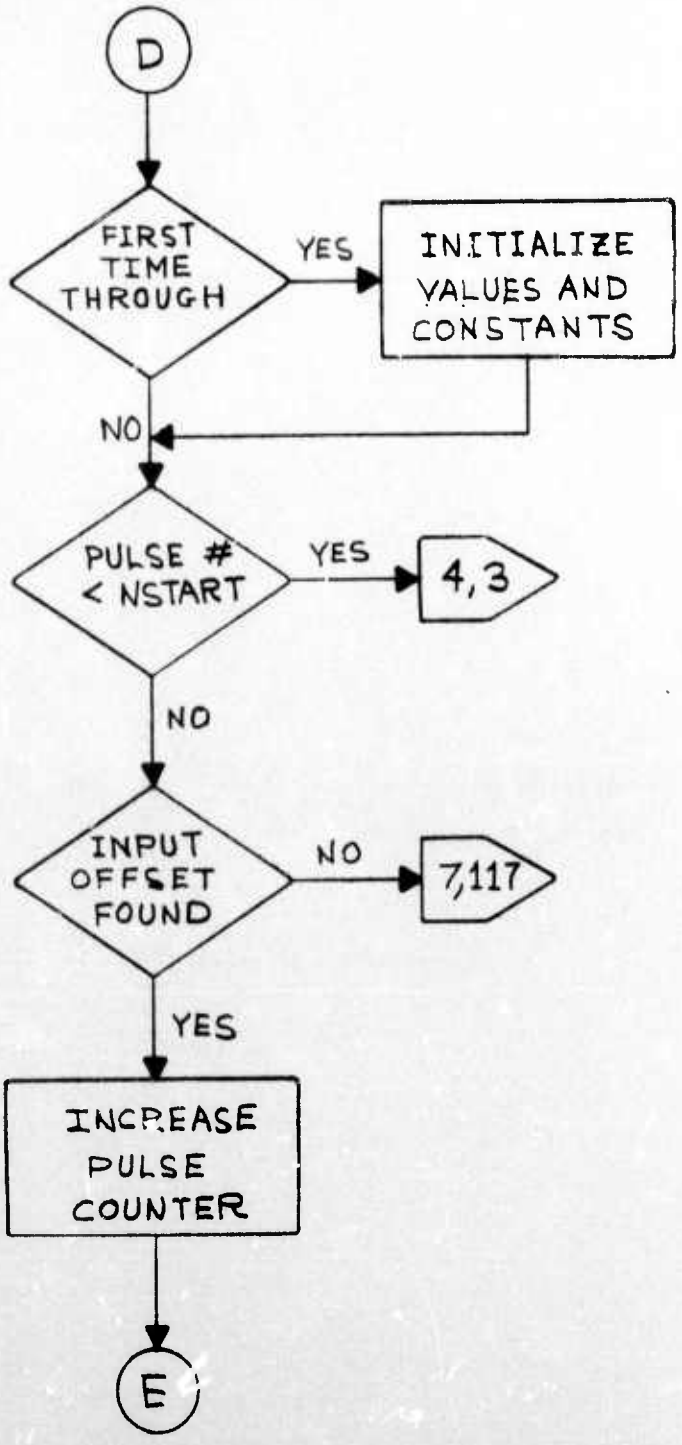

A
UPDATE COUNTER BY 1
COUNTER >ICASEN
YES
9,127
NO
READ INPUT CARDS
READGS
READ FIRST RECORD OF ADT
HEDADT
UNPACK HEADER RECORD
READGS
READ CALIBRATION RECORD
B


B
STORE CALIBRATION RECORD
LEGAL AVERAGING INTERVAL
NO
9,127
YES
GENERATE PROPER PRF TABLES
8,42
42
SET PROCESSING INTERVAL
DETERMINE FIRST AVERAGING INTERVAL
2
DETERMINE N^TH AVERAGING INTERVAL
7,2
C

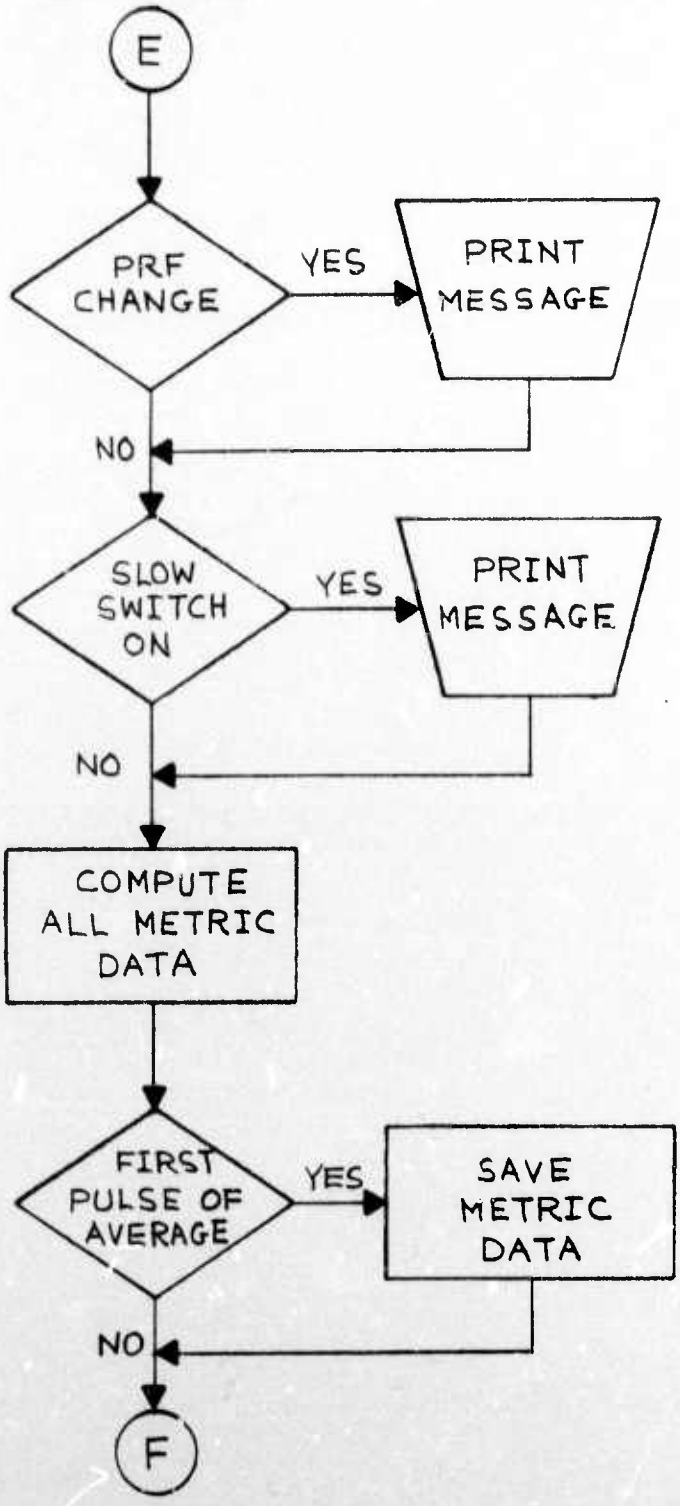
APPENDIX D-4


C
5,3
7,3
3
TIME TO READ A NEW RECORD
NO
YES
READGS
READ A NEW RECORD
INCREASE RECORD COUNTER
ERROR MESSAGE
YES
PARITY ERROR
NO
UNPACK
UNPACK A PULSE
COMPUTE R OFFSET
D

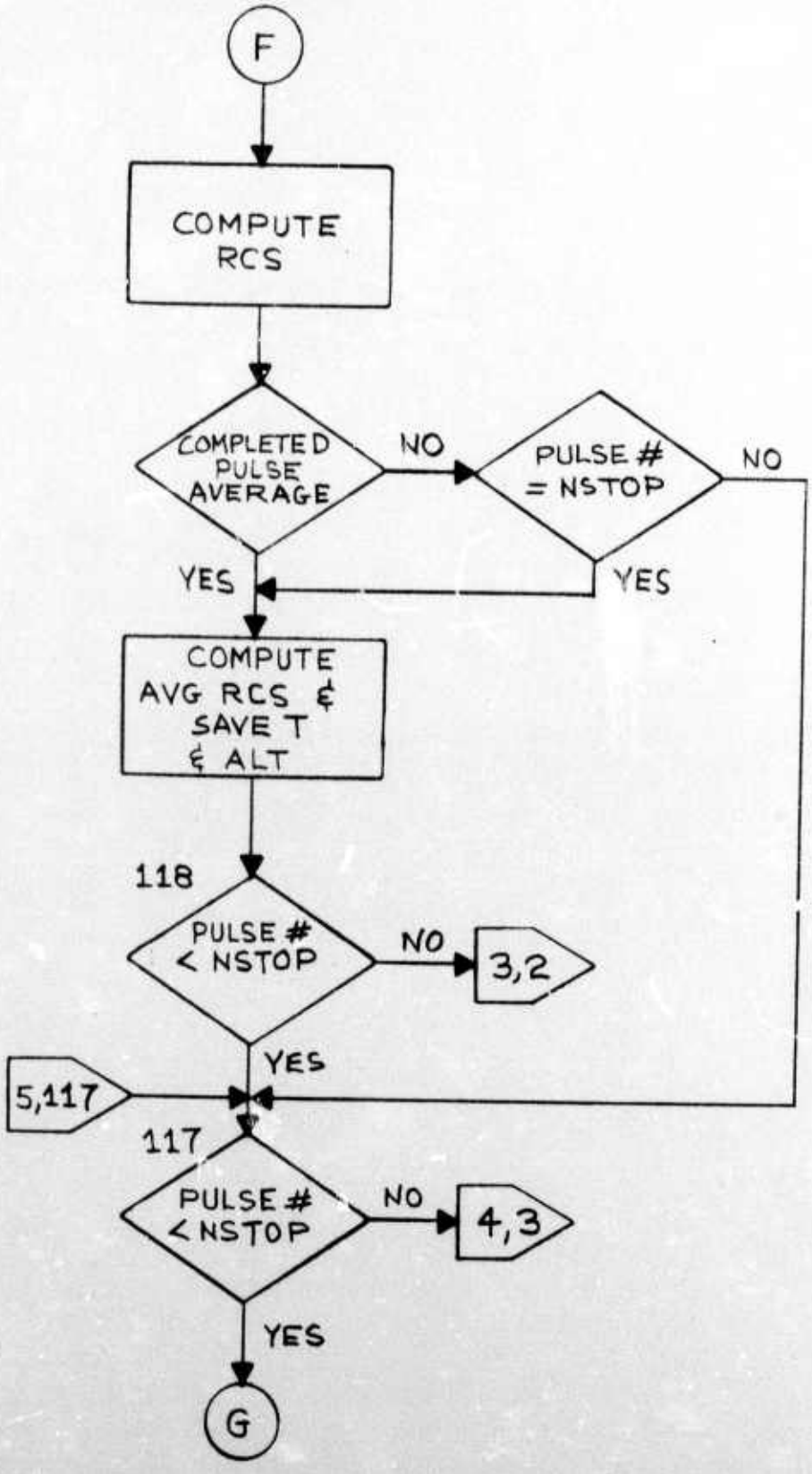
APPENDIX D-5


D
FIRST TIME THROUGH
YES
INITIALIZE VALUES AND CONSTANTS
NO
PULSE # < NSTART
YES
4,3
NO
INPUT OFFSET FOUND
NO
7,117
YES
INCREASE PULSE COUNTER
E

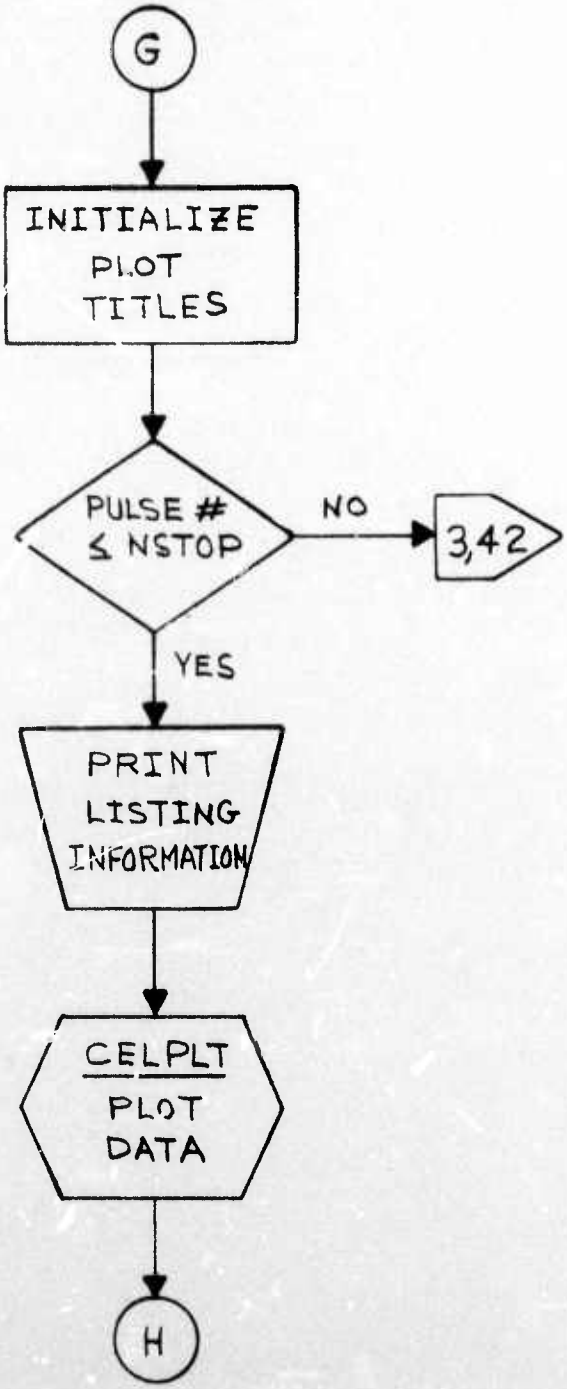
APPENDIX D-6


E
PRF CHANGE
YES
PRINT MESSAGE
NO
SLOW SWITCH ON
YES
PRINT MESSAGE
NO
COMPUTE ALL METRIC DATA
FIRST PULSE OF AVERAGE
YES
SAVE METRIC DATA
NO
F

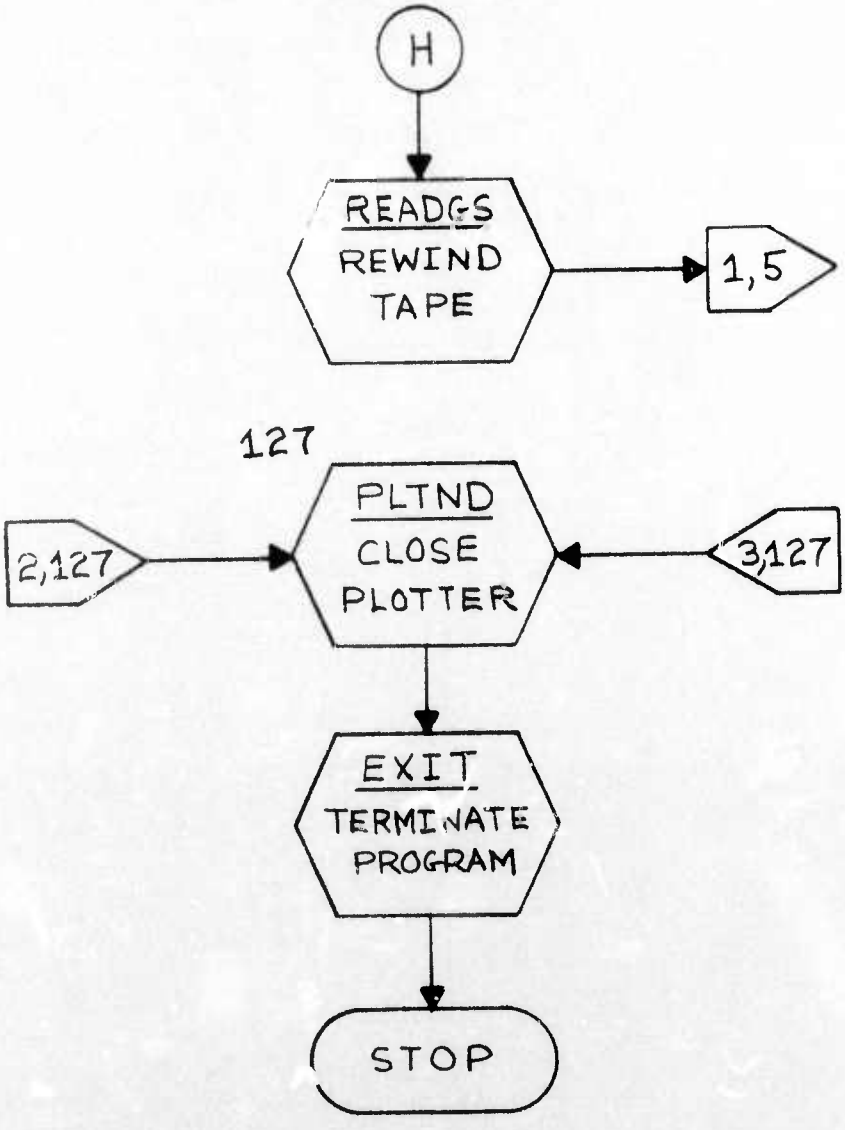
APPENDIX D-7


F
COMPUTE RCS
COMPLETED PULSE AVERAGE
NO
PULSE # = NSTOP
NO
YES
YES
COMPUTE AVG RCS & SAVE T & ALT
118
PULSE # < NSTOP
NO
3,2
YES
5,117
117
PULSE # < NSTOP
NO
4,3
YES
G

APPENDIX D-8


G
INITIALIZE
PLOT
TITLES
PULSE #
≤ NSTOP
NO
3,42
YES
PRINT
LISTING
INFORMATION
CELPLT
PLOT
DATA
H

APPENDIX D-9


H
READGS
REWIND
TAPE
1,5
127
PLTND
CLOSE
PLOTTER
2,127
3,127
EXIT
TERMINATE
PROGRAM
STOP

APPENDIX E

SUBROUTINE HEDADT PROGRAM LISTING

```
*               CALL HEDADT (ISIG,INBUF,IEQU)
*               ISIG = 1     UNPACK THE 20 WORD ADT HEADER
          START
          ENTRY HEDADT
          SPACE
XISIG     EQU   4
XICAL     EQU   5
XIEQU     EQU   6
BASE      EQU   12
          SPACE
HEDADT    SAVE  (14,12),T,*
          BALR  12,0
          USING *,BASE
          ST    13,SAVEA+4
          LA    7,SAVEA
          ST    7,8(0,13)
          LR    13,7
          SPACE
          LM    XISIG,XIEQU,0(1)
          SPACE
          L     8,0(XICAL)
          ST    8,TEMP1
          ST    8,TEMP2
          SRL   8,31
          ST    8,0(XIEQU)      MBAND
          L     8,TEMP1
          SLL   8,1
          SRL   8,25
          ST    8,4(XIEQU)      MREEL
          SPACE
          L     8,4(XICAL)
          ST    8,TEMP1
          ST    8,TEMP2
          SRL   8,16
          ST    8,8(XIEQU)      MWTR
          L     8,TEMP1
          SLL   8,16
          SRL   8,24
          ST    8,12(XIEQU)     MMNTH
          L     8,TEMP2
          SLL   8,24
          SRL   8,24
          ST    8,16(XIEQU)     MDAY
          SPACE
          SR    8,8
          IC    8,8(XICAL)
          ST    8,20(XIEQU)     MYEAR
          MVC   24(9,XIEQU),9(XICAL)    MISSION DES.
          SPACE
RETURN    L     13,SAVEA+4
          RETURN (14,12),T
          CNOP  0,4
TEMP1     DC    F'0'
TEMP2     DC    F'0'
SAVEA     DC    18A(*)
          END
```

APPENDIX F

SUBROUTINE READGS PROGRAM LISTING

```
*                CALL READGS(INBUF,IEOF,IERR)
          START
          ENTRY READGS
          SPACE
XZBUF     EQU   4
XEOF      EQU   5
XERR      EQU   6
BASE      EQU   12
          SPACE
READGS    SAVE  (14,12),T,*
          BALR  12,0
          USING *,BASE
          ST    13,SAVEA+4
          LA    7,SAVEA
          ST    7,8(0,13)
          LR    13,7
          SPACE
          LM    XZBUF,XERR,0(1)
          L     7,0(XEOF)
          C     7,TWO
          BE    S99
          SPACE
          L     7,IFRST1
          C     7,TWO
          BE    INIT2
          C     7,ZERO
          BNE   WHICHF
          SPACE
          OPEN  (INDCB,(INPUT))
INIT2     READ  RDB3,SF,INDCB,BUFF1,7212
          CHECK RDB3
          MVC   BUFNUM(4),ZERO
          MVC   IFRST1(4),ONE
          B     SK1
          SPACE
WHICHF    L     3,BUFNUM
          S     3,ONE
          BM    NEXTBUF2
          B     NEXTBUF1
          SPACE
NEXTBUF1  MVC   BUFNUM(4),ZERO
          CHECK RDB1
SK1       READ  RDB2,SF,INDCB,BUFF2,7212
          L     9,ABUFF1
```

```
         B      LOOPQ
         SPACE
NEXTBUF2 MVC    BUFNUM(4),ONE
         CHECK  RDB2
         READ   RDB1,SF,INDCB,BUFF1,7212
         L      9,ABUFF2
         SPACE
LOOPQ    LR     10,XZBUF
         SR     11,11
         SR     3,3
         LA     8,1803
LOOPZ    L      7,0(3,9)
         ST     7,0(11,10)
         BCT    8,INDUP
         B      OUTLP
INDUP    LA     3,4(3)
         LA     11,4(11)
         B      LOOPZ
OUTLP    B      RETURN
         SPACE
BADRD    L      2,ONE
         ST     2,0(XERR)
         BR     14
         SPACE
ENDFILE  L      2,ONE          STORE END OF FILE INDICATOR
         ST     2,0(XEOF)
S99      CLOSE  (INDCB,REREAD),TYPE=T
         MVC    IFRST1(4),TWO
RETURN   L      13,SAVEA+4
         RETURN (14,12),T
         SPACE
         CNOP   0,8
INDCB    DCB    DSORG=PS,MACRF=(RC),DEVD=TA,DEN=2,BUFNO=1,EODAD=ENDFILE,C
               SYNAD=BADRD,BFTEK=S,DDNAME=FT11F001
         SPACE
         CNOP
ZERO     DC     F'0'
ONE      DC     F'1'
TWO      DC     F'2'
IFRST1   DC     F'0'
BUFNUM   DC     F'0'
         SPACE
ABUFF1   DC     A(BUFF1)
ABUFF2   DC     A(BUFF2)
SAVEA    DC     18A(*)
         SPACE
BUFF1    DS     1803F
BUFF2    DS     1803F
         END
```

APPENDIX G

SUBROUTINE REFC PROGRAM LISTING

```
      SUBROUTINE REFC(E,R,OEE,ORR)                          VERSION 6/16/70
      DIMENSION OE(16,8),DR(16,8),EO(16),RO(8)
      DATA OE/0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,
     10.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0   ,0.0313,
     20.0303,0.0292,0.0287,0.0282,0.0272,0.0262,0.0253,0.0243,0.0223,
     30.0214,0.0195,0.0171,0.0135,0.0075,0.0   ,0.0937,0.0848,0.0770,
     40.0732,0.0694,0.0627,0.0571,0.0522,0.0480,0.0412,0.0385,0.0337,
     50.0278,0.0205,0.0105,0.0   ,0.1850,0.1520,0.1250,0.1140,0.1050,
     60.0904,0.0795,0.0708,0.0636,0.0523,0.0478,0.0405,0.0323,0.0229,
     70.0114,0.0   ,0.5310,0.3070,0.2120,0.1830,0.1600,0.1280,0.1060,
     80.0899,0.0780,0.0612,0.0550,0.0455,0.0354,0.0246,0.0120,0.0   ,
     90.7550,0.3720,0.2400,0.2020,0.1750,0.1370,0.1120,0.0942,0.0811,
     A0.0631,0.0566,0.0466,0.0361,0.0250,0.0122,0.0   ,0.9120,0.4110,
     B0.2560,0.2140,0.1840,0.1420,0.1150,0.0967,0.0830,0.0643,0.0575,
     C0.0472,0.0365,0.0252,0.0122,0.0   ,0.9700,0.4200,0.2600,0.2200,
     D0.1900,0.1460,0.1170,0.0980,0.0840,0.0653,0.0584,0.0478,0.0369,
     E0.0254,0.0123,0.0 /
      DATA OR/  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0, 22.6, 21.5, 20.4, 19.9,
     1  0.0,  0.0,  0.0,  0.0,  0.0,  0.0,  0.0, 22.6, 21.5, 20.4, 19.9,
     2 19.4, 18.5, 17.6, 16.8, 16.1, 14.8, 14.2, 13.2, 12.0, 10.4,  8.6,
     3  7.7, 67.3, 57.9, 50.2, 47.0, 44.1, 39.3, 35.4, 32.1, 29.3, 24.8,
     4 22.9, 19.7, 16.3, 12.7,  9.4,  8.1,132.0, 98.5, 77.4, 69.7, 63.2,
     5 52.9, 44.7, 38.4, 33.4, 26.4, 23.9, 20.1, 16.4, 12.7,  9.4,  8.1,
     6340.0,167.0,103.0, 86.1, 73.4, 56.7, 46.2, 38.9, 33.6, 26.4, 24.0,
     7 20.2, 16.4, 12.8,  9.5,  8.2,405.0,170.0,104.0, 86.3, 73.6, 56.8,
     8 46.3, 38.9, 33.7, 26.5, 24.1, 20.3, 16.5, 12.8,  9.5,  8.2,421.0,
     9171.0,104.0, 86.6, 73.9, 57.1, 46.4, 39.0, 33.8, 26.8, 24.3, 20.5,
     A 16.6, 13.0,  9.8,  8.4,446.0,172.0,105.0, 87.4, 74.0, 58.0, 46.6,
     B 39.2, 34.0, 27.0, 24.6, 20.7, 16.7, 13.0, 10.0,  8.4/
      DATA EO,RTDEG/0.01,2.0,4.0,5.0,6.0,8.0,10.0,12.0,14.0,18.,20.,
     124.,30.,40.,60.,90.,57.29578/
      DATA RO/0.01,10.,30.,60.,200.,400.,1000.,2000./
      IF(R.LE.0.0)GO TO 300
      RG=R/1.852D+00
      DO 100 IEO=2,15
      I=17-IEO
      IF(E.GE.EO(I))GO TO 120
  100 CONTINUE
      I=1
  120 DO 200 JRO=2,8
      J=10-JRO
      IF(RG.GE.RO(J))GO TO 220
  200 CONTINUE
      J=1
  220 IF(J.EQ.8)GO TO 340
      ZR=ALOG(RG/RO(J))/ALOG(RO(J+1)/RO(J))
      IF(E.LE.0.0)GO TO 320
      ZE=ALOG(E/EO(I))/ALOG(EO(I+1)/EO(I))
      OE1=((OE(I+1,J)-OE(I,J))*(1.-ZR)+(OE(I,J+1)-OE(I,J))*ZR)*ZE
      OE2=((OE(I-J+1)-OE(I,J))*(1.-ZE)+(OE(I+1,J+1)-OE(I,J+1))*ZE)*ZR
      OEE=OE1+OE2+OE(I,J)
      OR1=((DR(I+1,J)-OR(I,J))*(1.-ZR)+(OR(I,J+1)-OR(I,J))*ZR)*ZE
      OR2=((DR(I,J+1)-DR(I,J))*(1.-ZE)+(DR(I+1,J+1)-DR(I,J+1))*ZE)*ZR
      ORR=(OR1+DR2+OR(I,J))
      GO TO 400
  300 OEE=0.0
      ORR=0.0
      GO TO 400
  320 OEE=OE(I,J)+(OE(I,J+1)-OE(I,J))*ZR
      ORR=OR(I,J)+(DR(I,J+1)-DR(I,J))*ZR
      GO TO 400
  340 OELT=(E-EO(I))/(EO(I+1)-EO(I))
      OEE=OELT*(OE(I+1,J)-OE(I,J))+OE(I,J)
      ORR=OELT*(DR(I+1,J)-OR(I,J))+OR(I,J)
  400 ORR=ORR*.30480-03
      RETURN
      END
```